

New Hampshire Volunteer Lake Assessment Program

2003 Biennial Report for Lake Waukewan Meredith



NHDES
Water Division
Watershed Management Bureau
29 Hazen Drive
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OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **LAKE WAUKEWAN (MAYO and WINONA Stations), MEREDITH**, the program coordinators have made the following observations and recommendations:

Thank you for your continued hard work sampling the lake this season! Your monitoring group sampled **three** times this season and has done so for many years! As you know, with multiple sampling events each season, we will be able to more accurately detect changes in water quality. Keep up the good work!

FIGURE INTERPRETATION

- **Figure 1 and Table 1:** The graphs in Figure 1 (Appendix A) show the historical and current year chlorophyll-a concentration in the water column. Table 1 (Appendix B) lists the maximum, minimum, and mean concentration for each sampling season that the lake/pond has been monitored through the program.

Chlorophyll-a, a pigment naturally found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a, and are naturally found in lake ecosystems, the chlorophyll-a concentration measured in the water gives an estimation of the algal concentration or lake productivity. **The mean (average) summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 7.02 mg/m³.**

MAYO STATION

The current year data (the top graph) show that the chlorophyll-a concentration **remained fairly stable** from July to September. (Please note: the August chlorophyll-a sample was mistakenly collected in a white bottle instead of a dark brown, opaque bottle. The sample was rejected.) The chlorophyll-a concentration in July and September was **less than** the state mean.

The historical data (the bottom graph) show that the 2003 chlorophyll-a mean is ***much less than*** the state mean.

Overall, the statistical analysis of the historical data (the bottom graph) shows that the mean annual chlorophyll-a concentration has ***not significantly changed*** (either *increased* or *decreased*) since monitoring began in **1991**. Specifically, the chlorophyll-a concentration has remained ***relatively stable*** and has been ***less than*** the mean. (Note: Please refer to Appendix E for the detailed statistical analysis explanation and data print out.)

WINONA STATION

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The historical data (the bottom graph) show that the 2003 chlorophyll-a mean is ***much less than*** the state mean.

Overall, the statistical analysis of the historical data (the bottom graph) shows that the mean annual chlorophyll-a concentration has ***not significantly changed*** (either *increased* or *decreased*) since monitoring began in **1991**. Specifically, the chlorophyll-a concentration has remained ***relatively stable*** and has been ***less than*** the state mean. (Note: Please refer to Appendix E for the detailed statistical analysis explanation and data print out.)

While algae are naturally present in all lakes/ponds, an excessive or increasing amount of any type is not welcomed. In freshwater lakes/ponds, phosphorus is the nutrient that algae depend upon for growth. Algal concentrations may increase with an increase in nonpoint sources of phosphorus loading from the watershed, or in-lake sources of phosphorus loading (such as phosphorus releases from the sediments). Therefore, it is extremely important for volunteer monitors to continually educate residents about how activities within the watershed can affect phosphorus loading and lake quality.

- **Figure 2 and Table 3:** The graphs in Figure 2 (Appendix A) show historical and current year data for lake transparency. Table 3 (Appendix B) lists the maximum, minimum and mean transparency data for each sampling season that the lake has been monitored through the program.

Volunteer monitors use the Secchi-disk, a 20 cm disk with alternating black and white quadrants, to measure water clarity (how far a person can see into the water). Transparency, a measure of water clarity, can be affected by the amount of algae and sediment from erosion, as well as the natural colors of the water. **The mean (average) summer transparency for New Hampshire's lakes and ponds is 3.7 meters.**

MAYO STATION

The current year data (the top graph) show that the in-lake transparency **increased** from July to August, and **remained stable** from August to September. The transparency in July, August, and September was **greater than** the state mean.

The historical data (the bottom graph) show that the 2003 mean transparency is **greater than** the state mean.

Overall, the statistical analysis of the historical data (the bottom graph) show that the mean annual in-lake transparency has **not significantly changed** (either *increased* or *decreased*) since monitoring began in **1991**. Specifically, the in-lake transparency has remained **relatively stable** and has been **greater than** the state mean. (Note: Please refer to Appendix E for the statistical analysis explanation and data print out.)

WINONA STATION

The current year data (the top graph) show that the in-lake transparency **remained stable** throughout the summer. The transparency in July, August, and September was **greater than** the state mean.

The historical data (the bottom graph) show that the 2003 mean transparency is **greater than** the state mean.

Overall, the statistical analysis of the historical data (the bottom graph) show that the mean annual in-lake transparency has **not significantly changed** (either *increased* or *decreased*) since monitoring began in **1991**. Specifically, the in-lake transparency has remained **relatively stable** and has been **greater than** the state mean. (Note: Please refer to Appendix E for the statistical analysis explanation and data print out.)

Typically, high intensity rainfall causes erosion of sediments into lakes/ponds and streams, thus decreasing clarity. Efforts should continually be made to stabilize stream banks, lake shorelines,

disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake. Guides to Best Management Practices designed to reduce, and possibly even eliminate, nonpoint source pollutants, such as sediment loading, are available from DES upon request.

- **Figure 3 and Table 8:** The graphs in Figure 3 (Appendix A) show the amounts of phosphorus in the epilimnion (the upper layer) and the hypolimnion (the lower layer); the inset graphs show current year data. Table 8 (Appendix B) lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the lake has joined the program.

Phosphorus is the limiting nutrient for plant and algae growth in New Hampshire's freshwater lakes and ponds. Too much phosphorus in a lake/pond can lead to increases in plant and algal growth over time. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 11 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

MAYO STATION

The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration **decreased** from July to August, and **remained stable** from August to September. The phosphorus concentration in July, August, and September was **less than** the state median.

The historical data show that the 2003 mean epilimnetic phosphorus concentration is **less than** the state median.

The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration **decreased** from July to August, and **increased** from August to September. The phosphorus concentration in July was **greater than** the state median, and in August and September was **less than** the state median.

The historical data show that the 2003 mean hypolimnetic phosphorus concentration is **less than** the state median.

Overall, the statistical analysis of the historical data show that the phosphorus concentration in the epilimnion (upper layer) and the hypolimnion (lower layer) has **not significantly changed** (either *increased* or *decreased*) since monitoring began in **1991**. Specifically, the phosphorus concentration in the epilimnion has remained **relatively stable, below the state median**, while in the hypolimnion

the phosphorus concentration has ***fluctuated***, with most years measuring ***less than*** the state median. (Note: Please refer to Appendix E for the statistical analysis explanation and data print out.)

WINONA STATION

The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration ***remained stable*** throughout the summer. The phosphorus concentration in July, August, and September was ***less than*** the state median.

The historical data show that the 2003 mean epilimnetic phosphorus concentration is ***less than*** the state median.

The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration ***decreased*** from July to August, and ***remained stable*** from August to September. The phosphorus concentration in July was ***greater than*** the state median, and in August and September was ***less than*** the state median.

The historical data show that the 2003 mean hypolimnetic phosphorus concentration is ***less than*** the state median.

Overall, the statistical analysis of the historical data show that the phosphorus concentration in the epilimnion (upper layer) and the hypolimnion (lower layer) has ***not significantly changed*** (either *increased* or *decreased*) since monitoring began in **1991**. Specifically, the phosphorus concentration in the epilimnion has remained ***relatively stable, below the state median***, while in the hypolimnion the phosphorus concentration has ***fluctuated***, with most years measuring ***less than*** the state median. (Note: Please refer to Appendix E for the statistical analysis explanation and data print out.)

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about its sources and how excessive amounts can adversely impact the ecology and value of lakes and ponds. Phosphorus sources within a lake or pond's watershed typically include septic systems, animal waste, lawn fertilizer, road and construction erosion, and natural wetlands.

TABLE INTERPRETATION**➤ Table 2: Phytoplankton****MAYO and WINONA STATIONS**

Table 2 (Appendix B) lists the current and historic phytoplankton species observed in the lake. The dominant phytoplankton species observed in the samples of both stations this year were ***Chrysosphaerella* (Golden-Brown), *Asterionella* (Diatom), and *Rhizosolenia* (Diatom).**

Phytoplankton populations undergo a natural succession during the growing season (Please refer to the “Biological Monitoring Parameters” section of this report for a more detailed explanation regarding seasonal plankton succession). Diatoms and golden-brown algae are typical in New Hampshire’s less productive lakes and ponds.

An overabundance of cyanobacteria (previously referred to as blue-green algae) indicates that there may be an excessive total phosphorus concentration in the lake/pond, or that the ecology is out of balance. Some species of cyanobacteria can be toxic to livestock, pets, wildlife, and humans. (Please refer to the “Biological Monitoring Parameters” section of this report for a more detailed explanation regarding cyanobacteria).

➤ Table 2: Cyanobacteria (Blue-green algae)

Minimal amounts of the cyanobacteria ***Anabaena* and *Microcystis*** were observed in the plankton samples this season. ***These species, if present in large amounts, can be toxic to livestock, wildlife, pets, and humans.***

Cyanobacteria can reach nuisance levels when excessive nutrients and favorable environmental conditions occur. During September of 2003, a few lakes and ponds in the southern portion of the state experienced cyanobacteria blooms. This was likely due to nutrient loading to these waterbodies. As mentioned previously, many weeks during the Spring and Summer of 2003 were rainy, which likely resulted in a large amount of nutrient loading to surface waters.

The presence of cyanobacteria serves as a reminder of the lake’s delicate balance. Watershed residents should continue to act proactively to reduce nutrient loading into the lake by eliminating fertilizer use on lawns, keeping the lake shoreline natural, re-vegetating cleared areas within the watershed, and properly maintaining septic systems and roads.

In addition, residents should also observe the lake in September and

October during the time of fall turnover (lake mixing) to document any algal blooms that may occur. Cyanobacteria (blue-green algae) have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface and bloom. Wind and currents tend to “pile” cyanobacteria into scums that accumulate in one section of the lake. If a fall bloom occurs, please contact the VLAP Coordinator.

➤ **Table 4: pH**

Table 4 (Appendix B) presents the in-lake and tributary current year and historical pH data.

pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 5.5 severely limits the growth and reproduction of fish. A pH between 6.5 and 7.0 is ideal for fish. The mean pH value for the epilimnion (upper layer) in New Hampshire’s lakes and ponds is **6.5**, which indicates that the surface waters in state are slightly acidic. For a more detailed explanation regarding pH, please refer to the “Chemical Monitoring Parameters” section of this report.

MAYO STATION

The mean pH at the deep spot this season ranged from **6.10** in the hypolimnion to **6.73** in the epilimnion, which means that the water is ***slightly acidic***.

WINONA STATION

The mean pH at the deep spot this season ranged from **6.21** in the hypolimnion to **6.97** in the epilimnion, which means that the water is ***slightly acidic***.

Due to the presence of granite bedrock in the state and the deposition of acid rain, there is not much that can be done to effectively increase lake/pond pH.

➤ **Table 5: Acid Neutralizing Capacity**

Table 5 (Appendix B) presents the current year and historic epilimnetic ANC for each year the lake has been monitored through VLAP.

Buffering capacity or ANC describes the ability of a solution to resist changes in pH by neutralizing the acidic input to the lake. The mean ANC value for New Hampshire's lakes and ponds is **6.7 mg/L**, which indicates that many lakes and ponds in the state are "highly sensitive" to acidic inputs. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

MAYO STATION

The Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) continues to remain **less than** the state mean of **6.7 mg/L**. Specifically, the lake is classified by DES as **highly sensitive** to acidic inputs (such as acid precipitation).

WINONA STATION

The Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) continues to remain **slightly greater than** the state mean of **6.7 mg/L**. Specifically, the lake is classified by DES as **highly sensitive** to acidic inputs (such as acid precipitation).

➤ Table 6: Conductivity

Table 6 (Appendix B) presents the current and historic conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current. The mean conductivity value for New Hampshire's lakes and ponds is **62.1 uMhos/cm**. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

MAYO AND WINONA STATIONS

The conductivity has **increased** in the lake and inlets since monitoring began. In addition, the in-lake conductivity is **greater than** the state mean. Typically, sources of increased conductivity are due to human activity. These activities include septic systems that fail and leak leachate into the groundwater (and eventually into the tributaries and the lake), agricultural runoff, and road runoff (which contains road salt during the spring snow melt). New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could contribute to increasing conductivity. In addition, natural sources, such as iron deposits in bedrock, can influence conductivity.

We recommend that your monitoring group conduct stream surveys and storm event sampling along the inlet(s) with elevated conductivity so that we can determine what may be causing the increases.

For a detailed explanation on how to conduct rain event and stream

surveys, please refer to the 2002 VLAP Annual Report “Special Topic Article”, or contact the VLAP Coordinator.

➤ **Table 8: Total Phosphorus**

Table 8 (Appendix B) presents the current year and historic total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae’s ability to grow and reproduce. Please refer to the “Chemical Monitoring Parameters” section of this report for a more detailed explanation.

➤ **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**

Table 9 (Appendix B) shows the dissolved oxygen/temperature profile(s) for the 2003 sampling season. Table 10 (Appendix B) shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. Please refer to the “Chemical Monitoring Parameters” section of this report for a more detailed explanation.

The dissolved oxygen concentration was **high** at all depths sampled at the deep spot of the lake. As stratified lakes/ponds age, oxygen becomes **depleted** in the hypolimnion (lower layer) by the process of decomposition. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological oxidation of organic matter (i.e.; biological organisms using oxygen to break down organic matter), both in the water column and particularly at the bottom of the lake where the water meets the sediment. The **high** oxygen level in the hypolimnion is a sign of the lake’s overall good health.

➤ **Table 11: Turbidity**

Table 11 (Appendix B) lists the current year and historic data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the “Other Monitoring Parameters” section of this report for a more detailed explanation.

WINONA STATION

The turbidity of the hypolimnion (lower layer) sample was elevated on **August 14 and September 10, 2003**. This suggests that the lake bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling. When the lake bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. When collecting the hypolimnion sample, please check

to make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

DATA QUALITY ASSURANCE AND CONTROL

Sample Receipt Checklist

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if the volunteer monitors followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, future re-occurrences of improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did a **very good** job when collecting samples this season! Specifically, the members of your monitoring group followed the majority of the proper field sampling procedures when collecting and submitting samples to the laboratory. However, the laboratory did identify one aspect of sample collection that the volunteer monitors could improve upon. It is as follows:

- **Sample Bottles:** The chlorophyll-a sample for the **August 15** sampling event was not collected in the appropriate bottle. Specifically, the chlorophyll sample should be collected in the big brown light-proof bottle to limit the algae's ability to photosynthesize and produce more chlorophyll during the time period after sample collection and prior to analysis. Therefore, the sample was rejected for analysis.

NOTES

MAYO STATION

- **Monitor's Note (7/9/03):** Light rain while sampling
- **Biologist's Note (8/14/03):** Chlorophyll sample not run due to an improper sampling bottle being used

WINONA STATION

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OBSERVATIONS AND RECOMMENDATIONS

2003

- In June 2003, an area resident sampled the Snake River, which flows from Lake Winona into Lake Waukegan (near the Winona station). Samples were collected at several sites along the river. The water quality did not differ drastically from one station to the next. Total Phosphorus ranged from 7 to 11 ug/L and all conductivity values were below 100 uMhos/cm.

USEFUL RESOURCES

Acid Deposition Impacting New Hampshire's Ecosystems, ARD-32, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/ard/ard-32.htm.

Aquarium Plants and Animals: Don't leave them stranded. Informational pamphlet sponsored by NH Fish and Game, Aquaculture Education and Research Center, and NHDES (603) 271-3505.

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, NHDES-WD 97-8, NHDES Booklet, (603) 271-3503.

A Boater's Guide to Cleaner Water, NHDES pamphlet, (603) 271-3503.

Camp Road Maintenance Manual: A Guide for Landowners. Kennebec Soil and Water Conservation District, 1992, (207) 287-3901.

Comprehensive Shoreland Protection Act, RSA 483-B, WD-SP-5, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-5.htm.

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/wmb/wmb-10.htm.

Erosion Control for Construction in the Protected Shoreland Buffer Zone, WD-SP-1, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-1.htm

Impacts of Development Upon Stormwater Runoff, WD-WQE-7, NHDES Fact Sheet, (603) 271-3503, or www.des.state.nh.us/factsheets/wqe/wqe-7.htm

Iron Bacteria in Surface Water, WD-BB-18, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-18.htm

Is it Safe to Eat the Fish We Catch? Mercury and Other Pollutants in Fish, NH Department of Health and Human Services pamphlet, 1-800-852-3345, ext. 4664.

Lake Protection Tips: Some Do's and Don'ts for Maintaining Healthy Lakes, WD-BB-9, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-9.htm.

Management of Canada Geese in Suburban Areas: A Guide to the Basics, Draft Report, NJ Department of Environmental Protection Division of Watershed Management, March 2001, www.state.nj.us/dep/watershedmgt/DOCS/BMP_DOCS/Goosedraft.pdf.

Proper Lawn Care In the Protected Shoreland, The Comprehensive Shoreland Protection Act, WD-SP-2, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-2.htm.

Road Salt and Water Quality, WD-WMB-4, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/wmb/wmb-4.htm.

Sand Dumping - Beach Construction, WD-BB-15, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-15.htm.

Swimmers Itch, WD-BB-2, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-2.htm.

Through the Looking Glass: A Field Guide to Aquatic Plants. North American Lake Management Society, 1988, (608) 233-2836 or www.nalms.org.

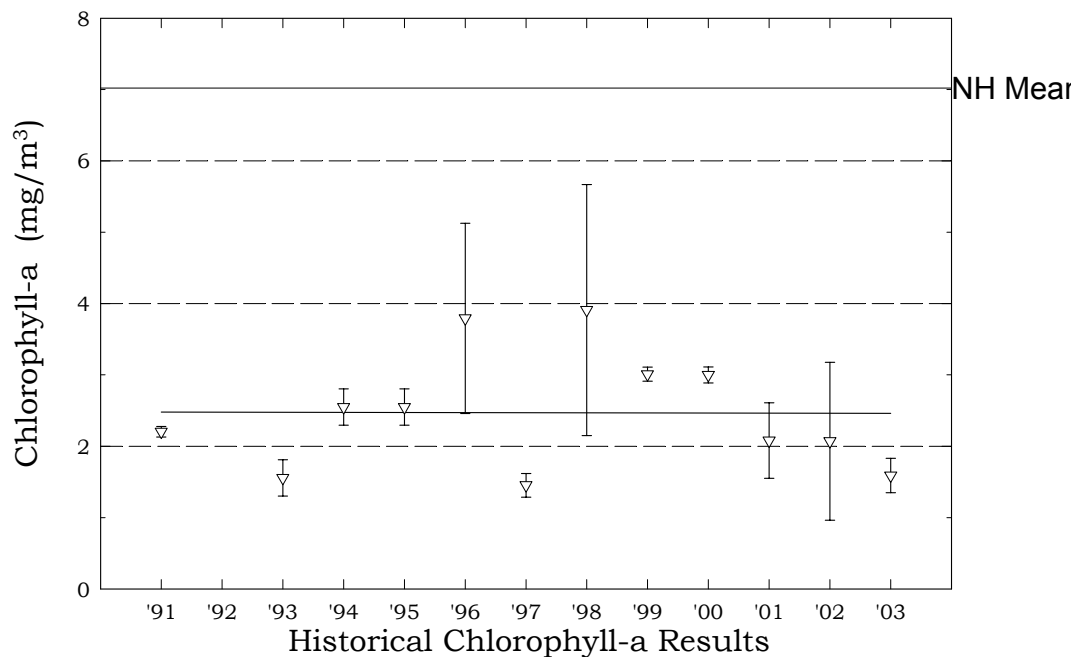
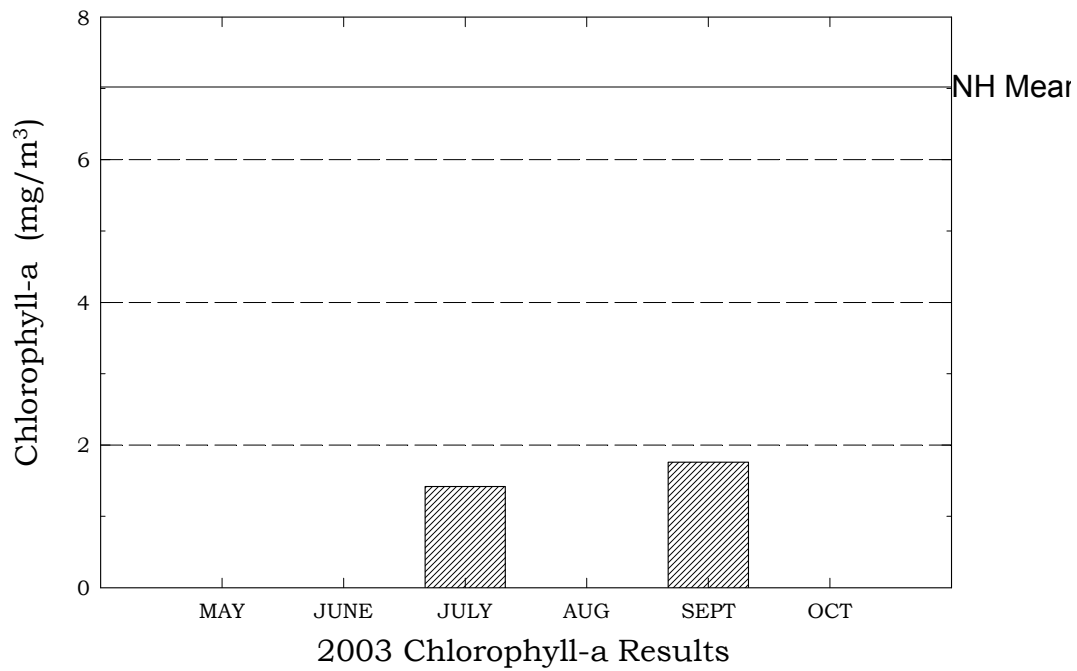
Weed Watchers: An Association to Halt the Spread of Exotic Aquatic Plants, WD-BB-4, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-4.htm.

APPENDIX A

GRAPHS

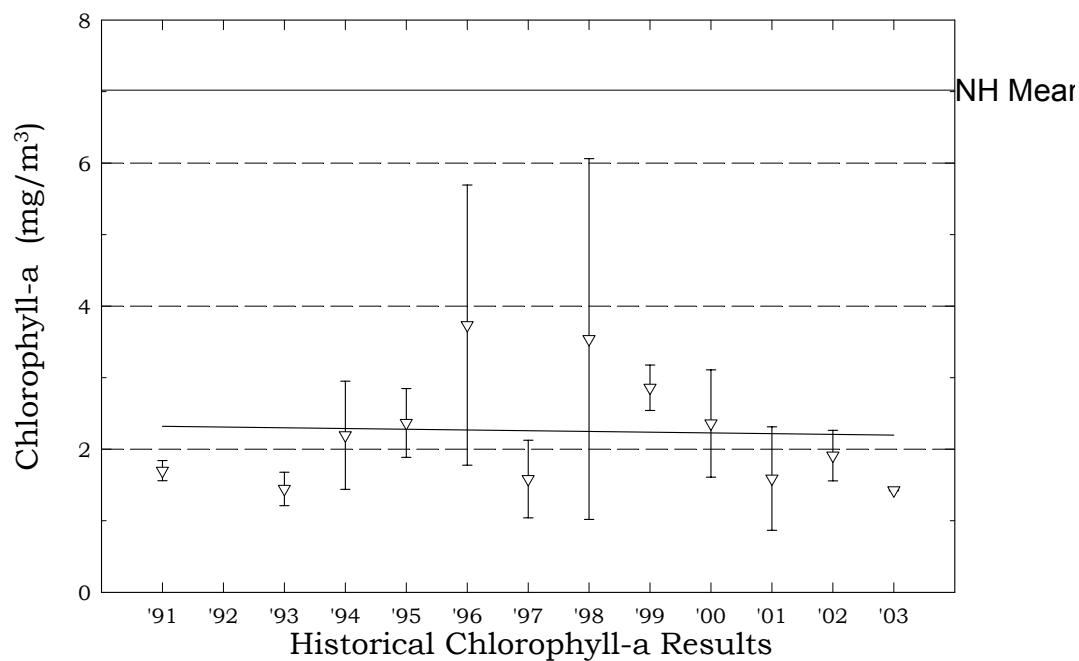
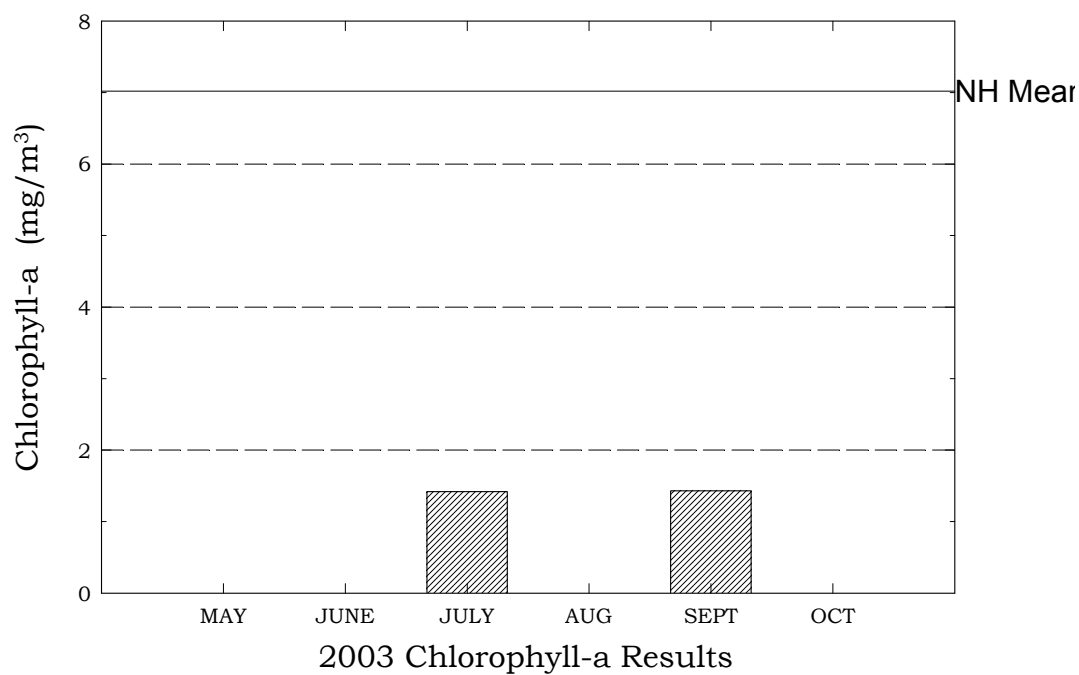
Lake Waukewan, Mayo Stn

Figure 1. Monthly and Historical Chlorophyll-a Results



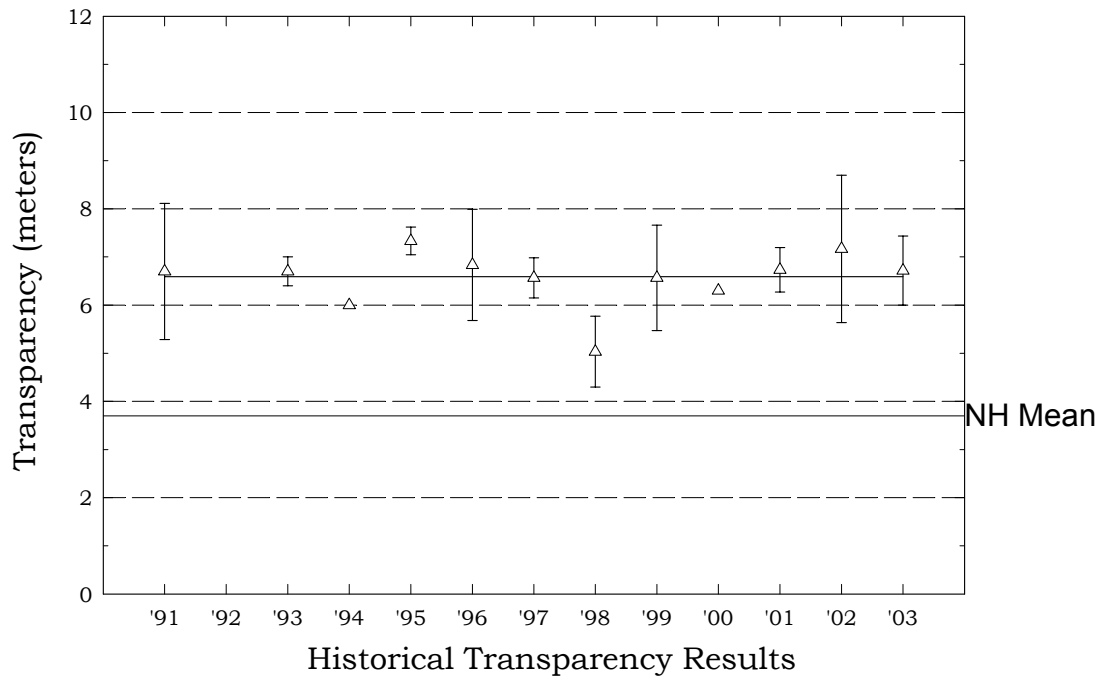
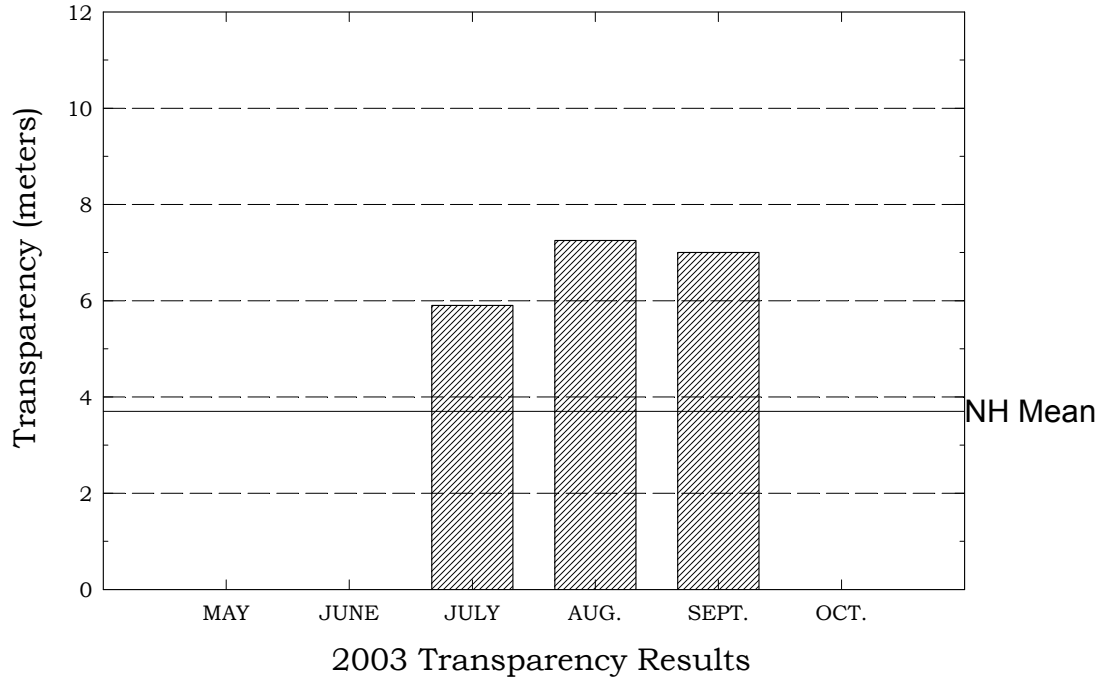
Lake Waukewan, Winona Stn

Figure 1. Monthly and Historical Chlorophyll-a Results



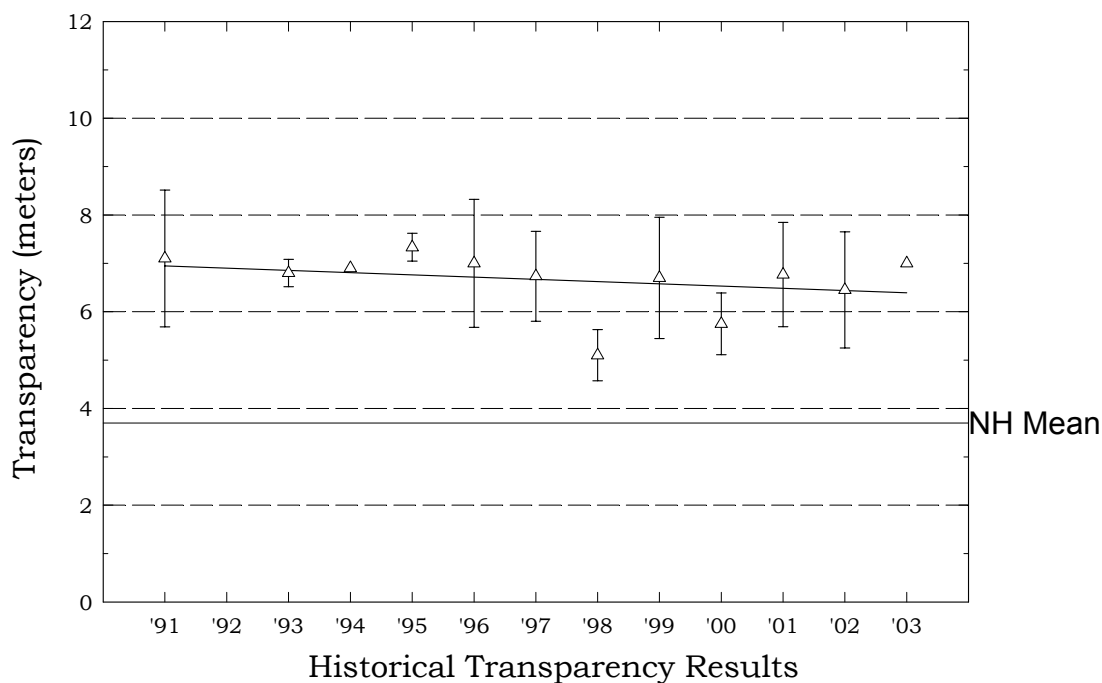
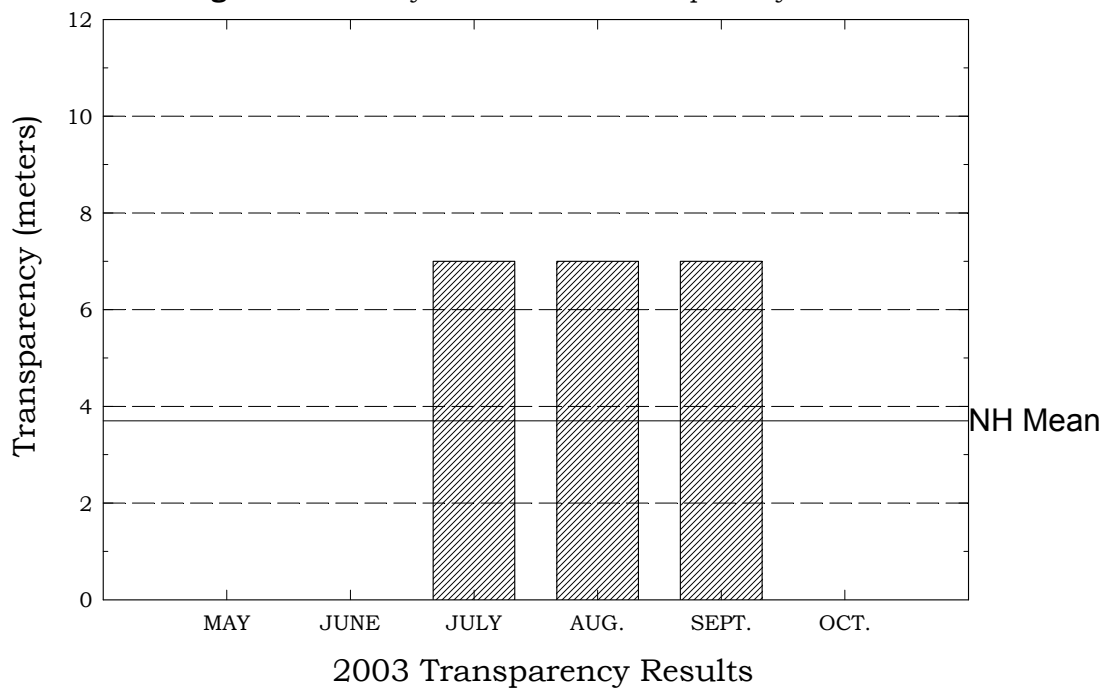
Lake Waukewan, Mayo Stn

Figure 2. Monthly and Historical Transparency Results



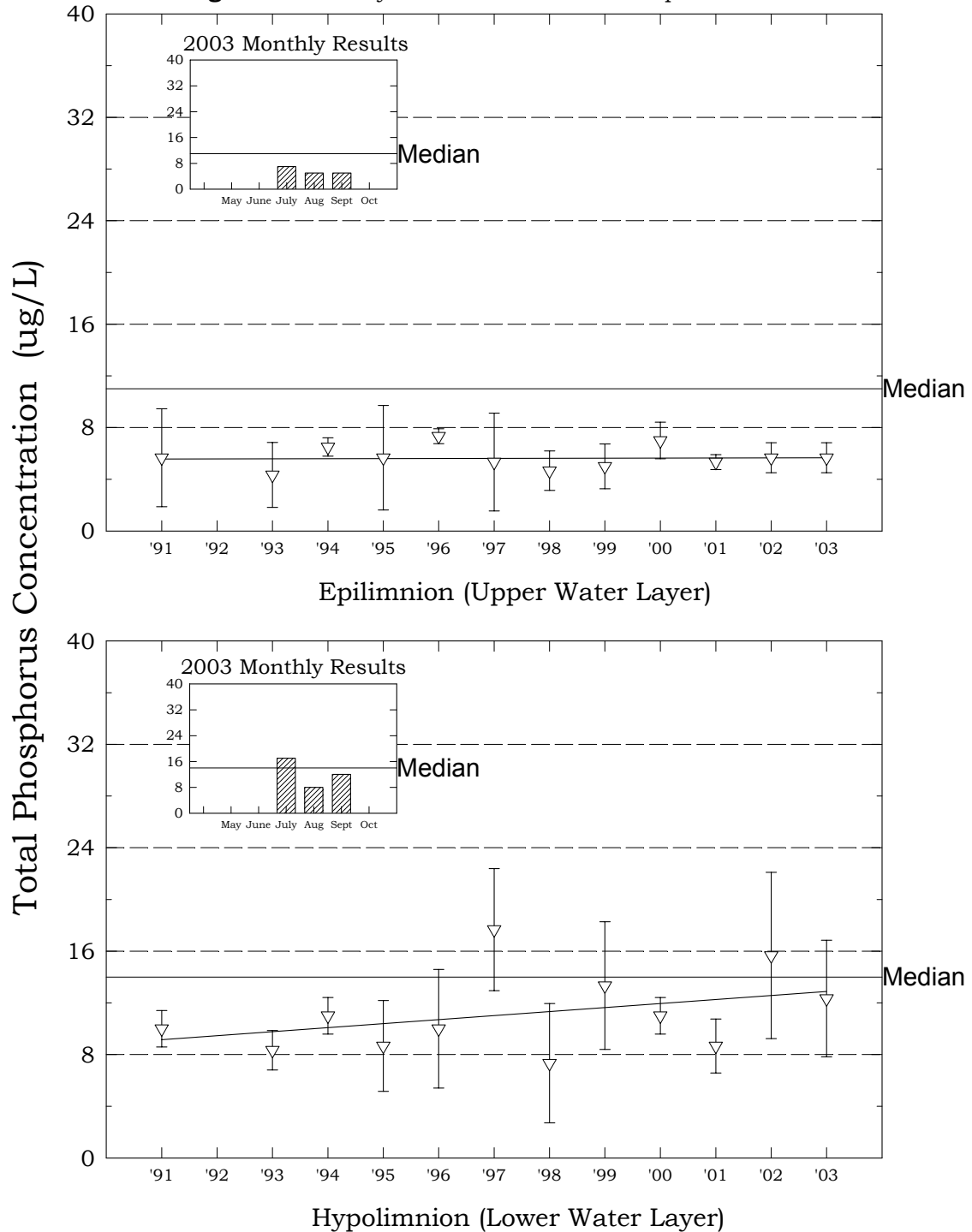
Lake Waukewan, Winona Stn

Figure 2. Monthly and Historical Transparency Results



Lake Waukewan, Mayo Stn

Figure 3. Monthly and Historical Total Phosphorus Data.



Lake Waukewan, Winona Stn

Figure 3. Monthly and Historical Total Phosphorus Data.

